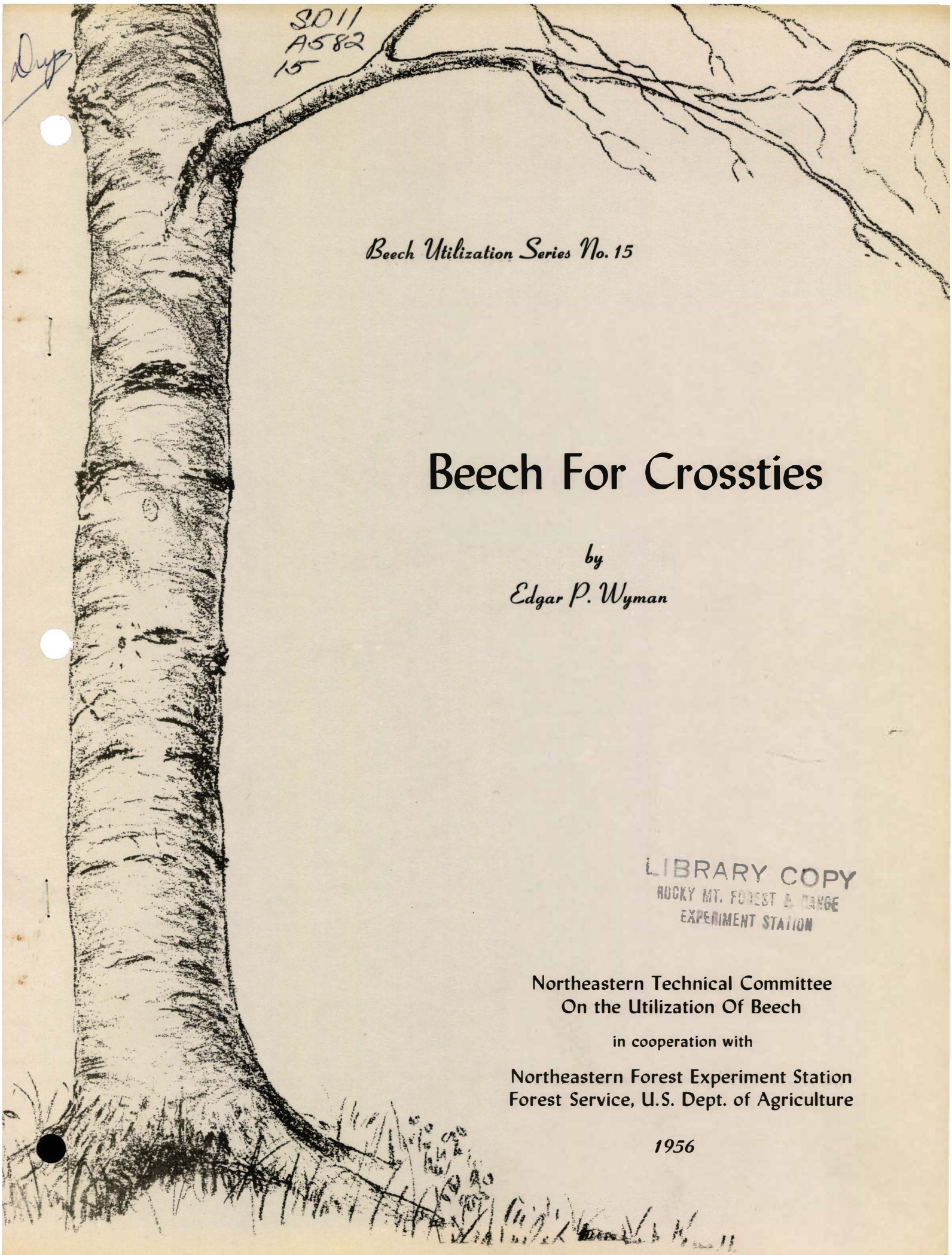

Beech Utilization Series No. 15

Beech For Crossties

by

Edgar P. Wyman

Northeastern Technical Committee
On the Utilization Of Beech

in cooperation with

Northeastern Forest Experiment Station
Forest Service, U.S. Dept. of Agriculture

1956

FOREWORD

The wood of the American beech tree (Fagus grandifolia Ehrh.) is well suited for a large number of uses, and it is rather widely used by manufacturers. Yet the amount used is not in proportion to the amount that grows in our northeastern forests. The utilization of beech--both in the woods and in the factory--has been recognized as a problem.

One reason for this is in the nature of the wood: it has a reputation for being difficult to season. Another is that many of the beech trees in our forests are of poor quality. And there are some plain prejudices against beech.

Research is finding ways to utilize beech as efficiently as any of the other comparable hardwoods can be handled. Considerable information about beech has been gathered. Yet most of this information is available only in fragmentary form in scattered technical reports. Some of it has never been published.

To study the problems of putting beech to the uses it deserves, and to promote the better management of the forests in which it grows, a Northeastern Technical Committee on the Utilization of Beech was organized in 1949. This committee, which includes representatives of Federal and State forestry agencies, universities, and state experiment stations, decided to assemble and publish the available information about the utilization of American beech.

As its part of this cooperative project, the Northeastern Forest Experiment Station has undertaken to edit, publish, and distribute the series of reports that will contain this information.

The subjects of these reports will be as follows:

* Physical and mechanical properties of American beech.

(CONTINUED ON INSIDE OF BACK COVER)

Beech For Crossties

by

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INTRODUCTION

APPROXIMATELY 30 percent of the Class I railroad trackage of the United States is found in the nineteen Eastern States where beech is a common species; and about 21 percent is within the twelve states (Maine, New Hampshire, Vermont, Massachusetts, New York, Pennsylvania, West Virginia, Michigan, Indiana, Kentucky, Tennessee, and Ohio) where beech makes up 6 to 15 percent of the total hardwood lumber production (13).[1] Within these twelve states, which will be referred to as the "beech area," lie 37,923 miles of Class I railroad track. At an average of about 3,000 crossties per mile, this represents some 114 million ties in use, or the equivalent of about 4.23 billion board feet of timber.

The most recent year for which complete statistics for tie production and treating are available is 1947 (13). For that year the production of sawed crossties in the beech

[1]Underlined numbers in parentheses refer to Literature Cited, page 12.

area was about 5.2 million ties, or 194 million board feet. The production of hewed ties was not listed, but in general hewed ties are produced farther south and in the Rocky Mountains; sawed ties predominate in the beech area. Of the 5.2 million sawed ties produced in 1947 in the beech area, 97 percent were hardwood; and of the hardwood ties 69 percent were oak, 24 percent mixed hardwoods, and 7 percent gum. The mixed hardwoods include such species as beech, birch, maple, ash, hickory, elm, and others of minor importance.

During the decade 1940-49 an average of 48 million ties were installed in U. S. railroad tracks annually. Of these, 97 percent were treated; and we can safely assume that practically all ties used by major U. S. railroads in the future will be treated. Therefore consideration of a species for tie use need not be made on the basis of its natural resistance to decay, but rather on its capacity to withstand the mechanical stresses to which a tie is subjected, and its capacity to accept preservative treatment.

In the decade before 1945 an average of 790,000 beech ties, (about 1.7 percent of the total) were treated in the United States annually. In 1946 this number dropped to 59,000, in 1947 to less than 8,000; and for the years since then no figures are available and the number is presumably negligible. During this period 41 percent of all ties treated were oak.

Wherever it is available, red oak has been accepted on the basis of use and experience as the tie species that is most satisfactory in mechanical strength, ease of treatment, and availability. On the other hand, oak is in steady demand by competing industries, for such products as lumber, flooring, cooperage, and furniture. This competition has the effect of raising the cost of stumpage for the tie producers, while seriously cutting into the supply of the best young oak growing stock. Young, fast-growing trees of tie size (12 to 15 inches d.b.h.) are eagerly sought by portable tie mill operators on a large scale; and in some areas this drain has actually prevented the development of other oak-using industries.

It is never a healthy condition for any industry to become too dependent on a single species for its raw material; and the potentialities of alternate species should be investigated as thoroughly as possible before an unforeseen epidemic or a change in stumpage price can cause an emergency search for a substitute for the preferred species. In

the more northerly part of the beech area the dominant hardwoods are birch, beech, and maple. Birch and maple are already in strong demand by numerous wood-using industries. If beech could be used to produce a satisfactory tie, the numerous silvicultural and economic problems of the area would be simplified. The purpose of this paper is to evaluate the characteristics of beech for use as crossties.

COMPARATIVE STRENGTH PROPERTIES AND RESISTANCE TO WEAR

According to the U. S. Forest Products Laboratory (14), the chief strength properties considered in wood for crosstie use are: (1) bending strength; (2) end hardness and strength in compression parallel to grain, which are indicative of resistance to spike-pulling and lateral thrust of spikes; (3) side hardness and compression perpendicular to the grain, which indicate resistance to wear under the rail or tieplates. A table of composite strength figures for tie woods developed by Markwardt shows how the main hardwood species of the beech region rank in these qualities (table 1).

Table 1.--Comparative strength and specific gravity of woods used for crossties (14)

Species	Composite strength*	Specific gravity**
Black locust	161	0.66
Hickory	141	.65
Honey locust	133	.60
Sugar maple	112	.56
White ash	108	.54
Black birch	108	.60
Rock elm	103	.57
White oak	103	.59
Red oak	100	.57
Beech	97	.56
Yellow birch	94	.55

*A combination rating of strength factors considered important for satisfactory crosstie service.

**Based on volume when green and weight when oven-dry.

Although beech is well down on this list, it is practically equal to red oak--the most commonly used tie species--in these strength qualities. The species that rank above red oak and beech are ruled out of use for crossties because of comparative scarcity, competing markets, or other reasons. Note also (table 1) how closely the relative strength figures parallel specific gravity.

In a recent small-scale study of ties taken out of use in regular tie-removal programs, the Timber Engineering Company found indications that beech stood up better than red oak in failures under the tie plates due to lateral shifting of the load (6). They also found that, in general, the diffuse-porous woods (such as beech, birch, and maple) apparently had superior over-all resistance to this type of wear; failure was at a minimum with these woods, and it was limited to the extreme top surface. In this study, not enough beech was studied to more than suggest confirmation of the data in table 1.

In the Von Schrenk Collection of wood-preservative materials at the University of Minnesota is a creosoted beech tie that was rail-cut to a depth of 2 centimeters in 51 years of use on the French Eastern Railroad. Apparently this tie was not protected by a plate. Though this was doubtless European beech, a comparison of physical and mechanical test data in the literature shows no significant difference in strength and hardness characteristics of American and European beech, except in modulus of elasticity.

Correspondence about the use of beech for crossties was carried on with 31 railraods within and near the beech area. Though practically all agreed that seasoning and treating beech are problems, several commented favorably on the strength and wear-resistance characteristics of the species. One particularly interesting comment was this: "For the very heavy wheel loads of a coal-hauling railroad we need strong, hard ties. I feel that beech is such a tie, and that a regular tie purchase program...should include the purchase of beech."[2]

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[2]Communication from H. C. Griggs, supervisor, timber treatment, Baltimore & Ohio Railroad.

DURABILITY

AND SEASONING PROBLEMS

The problems of shrinking and checking of beech in storage are so intimately tied in with the problems of fungus infection and durability that it would be unrealistic to consider them independently. The storage and seasoning of beech have been discussed in other reports in this series (12, 1); so these matters will be discussed here only as they have an influence on the use of beech for ties.

Even though practically all ties now going into service are treated with preservative, a consideration of the durability of untreated beech is necessary since one of the more serious problems in handling beech crossties is their tendency toward fungus infection while seasoning. Whether or not this can be overcome by proper handling and storage during seasoning is the vital point.

According to the American Woods Series leaflets published by the U. S. Forest Service (2): "Beech has a very large shrinkage, and requires considerable care in seasoning, if checks, warping, or discoloration are to be avoided. The wood is not resistant to decay. In this respect it is classed with birch, maple, and red oak..."

Brown, Panshin, and Forsaith say in their Textbook of Wood Technology (4) that beech is a wood--"...with unusually high shrinkage, checks, warps, and splits in seasoning unless very carefully dried, moderately durable to non-durable; lumbermen sometimes recognize two grades, according to the color of the heartwood, red and white beech. The former is considered to be the more durable."

Air-drying of beech is obviously much simpler for lumber than for logs and tie-size timbers, in which end- and surface-checking is a most difficult problem. In any case, beech logs cut in the summer months are apt to end-check very quickly--in a few hours, in fact--when exposed to direct sunlight. Beech cut for ties in the summer should be "hot-logged" to the mill as quickly as possible; and the problem can thus be simplified somewhat from the storage of logs to the storage of ties. Winter-cut beech logs allow somewhat more delay in storage and transit; but even so they should be manufactured as quickly as possible, and in no case allowed to remain in the woods, or even decked at the mill, after warmer weather arrives (12).

Since beech ties must be dried for treating, the reduction of deep checking in drying is a most important factor in its ability to resist fungus infection in the yard. One large pressure-treating company (the Koppers Company of Nashua, New Hampshire) has begun to incise beech ties before stacking in the yard; they say that this has greatly decreased deep surface checking, has distributed the drying stresses evenly over the surface of the tie, and has made a deeper and more uniform pressure treatment possible. The Boston & Maine Railroad (11) has had a similar experience in incising hardwood ties. They have found the reduction in checking and the improvement in treating so definite during the 15 years that they have been experimenting that they are now incising all hardwood ties, including oak.

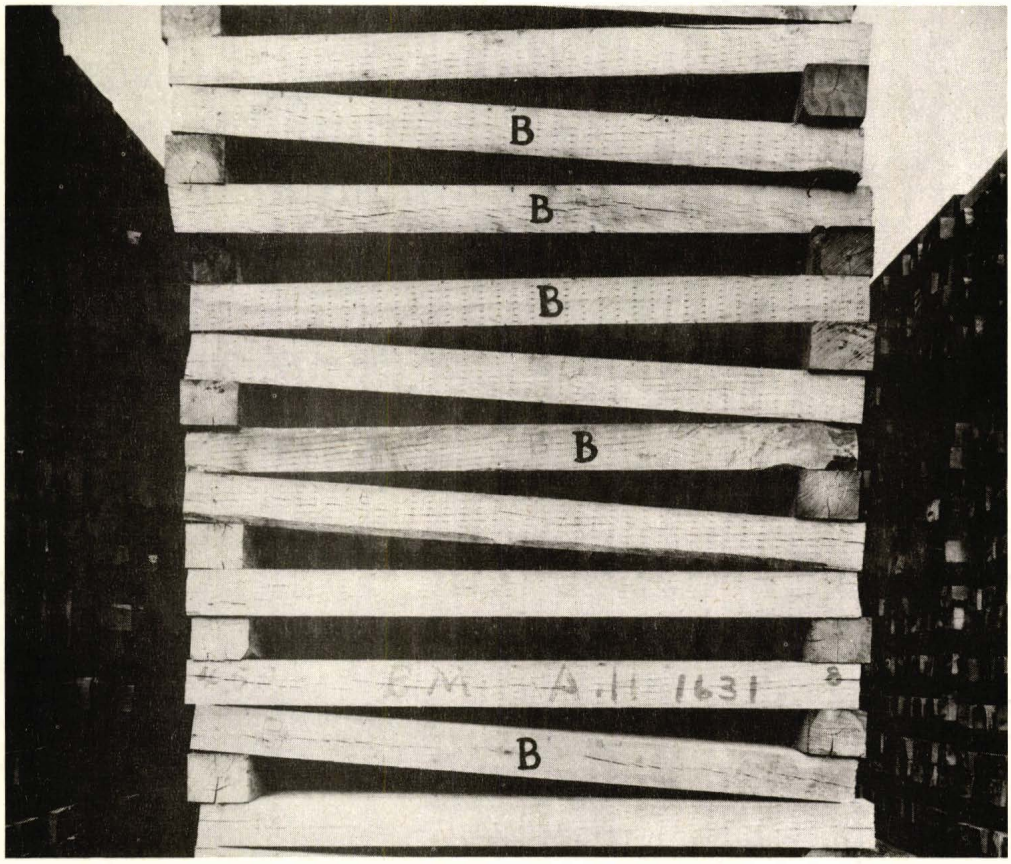

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Figure 1.—These railroad ties, stacked in the yard of a treating plant, have been incised and are ready for preservative treatment. All those marked with a *B* are beech; the others are ash and maple. The Boston & Maine Railroad owns these ties.

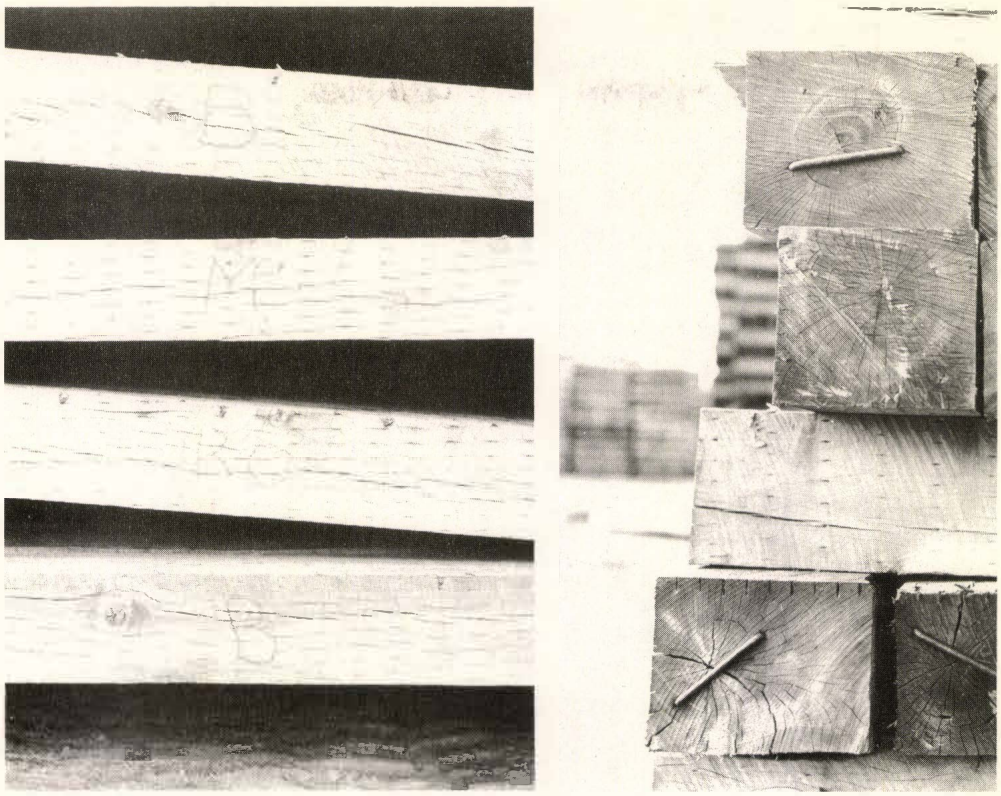

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Figure 2.—Close views of ties in the stacks. *Left:* side view, showing *(from top down)* beech, maple, red oak, and beech ties. *Right:* end view, showing *(from top down)* beech, maple, and maple ties. The beech ties here seem to be seasoning just as well as the ties of other species.

The Baltimore & Ohio Railroad is now purchasing about 25 percent of its tie requirements in beech, hickory, ash, hard maple, gum, birch, and cherry (5). It is stated that: "As a general rule we find that the mixed hardwoods, if properly seasoned and treated, have a life expectancy at least equal to the oaks, and if their tendency to split is controlled, they may give even better results".

End-checking or splitting cannot, of course, be controlled by incising. The Baltimore & Ohio Railroad (5) has found that selective doweling of ties that develop splits during seasoning is a successful solution, and that the added cost of doweling is well justified by added service

life of the ties. The Santa Fe Railroad (3) is another that is both incising and doweling problem ties. Anti-checking irons are also used by some roads to reduce end-checking.

TREATABILITY AND SERVICE LIFE OF TREATED BEECH TIES

Since practically all ties now put into service are treated, the ability of beech to take pressure treatment, and its durability after treating, are extremely important. Untreated, the heartwood of beech is relatively non-durable. The so-called "white heartwood" is not difficult to treat; but the "red heartwood" is difficult to treat, even by pressure processes.[3]

Two factors make it difficult to evaluate the in-service records of beech ties and compare them with other species. In the first place, the red and white heartwood ties are seldom segregated. And in the second, where records are available at all, beech ties are usually included among "miscellaneous hardwoods" (also called "T. C. hardwoods"). However, there is some excellent evidence that beech ties, when pressure-treated with creosote, have proved to have excellent serviceability.

In a test by the Santa Fe Railroad,[4] 1,630 beech ties had been removed by January 1949, and their average service life was 25.4 years. At that time 281 beech ties remained in service.

In 1910 the former Buffalo, Rochester & Pittsburgh line started a test of ties on what is now the Buffalo Division of the Baltimore & Ohio (5). The ties included about 20 percent mixed oak; the remainder were mixed hardwoods, most of which were beech and hard maple, with some hickory and other species. The ties were treated with 10 pounds of straight creosote. This test was closed out in 1952. All ties gave excellent service, with little variation in the life obtained by the oaks or mixed hardwoods.

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[3]Communication from Edward Panek, technologist, U.S. Forest Products Laboratory, Madison, Wis., 1950.

[4]Communication from D.L. Murray, manager, treating plants system, Atchison, Topeka & Santa Fe Railroad, 1951.

In the fall of 1912 the Chicago & Eastern Illinois Railroad inserted in a test track a number of creosoted ties; the results found in 1939 are shown in table 2. In 1939 a greater percentage of beech ties remained in service than either of the other species being tested.

Table 2.--Service data on creosoted ties in Chicago & Eastern Illinois Railroad test track (9)

Species	1912 Ties placed	1939 Ties removed		1939 average life of ties removed
	No.	No.	Percent	Years
Elm	1,356	697	51.4	24.22
Red oak	2,820	1,556	55.2	24.21
Beech	1,507	719	47.7	24.15

In the twenty-ninth annual inspection of the Chicago, Burlington & Quincy Railroad experimental ties (8), the actual average service life of the full-cell creosoted ties was as indicated in table 3. A further check of beech alone reported by letter for the benefit of this study by the superintendent of timber preservation for the C. B. & Q. indicated that in 1951 the average life of these beech ties was 30.0 years. It was stated, incidentally, that these were "northern beech," most of which had heartwood completely surrounded by sapwood. These are, of course, relatively easy to treat.

The Baltimore & Ohio Railroad, with an estimated 5 percent of the ties in its track beech, reports that beech shows up very well. In fact, its average life is nearly that of oak.[5] The results of long-term tests of treated beech ties by the Baltimore & Ohio are shown in tables 4 and 5.

It is interesting to note in table 5 that though 14.1 percent of the red oak ties have been removed from service,

[5]Communication from H. C. Griggs, supervisor, timber treatment, Baltimore & Ohio Railroad.

only 5 percent of the sap beech and 7 percent of the heart beech ties have been removed. The extraordinary absorption of the preservative by the usually refractory heart beech is not explained.

Table 3.--Results from 32 years' use of creosoted ties in Chicago Burlington & Quincy test tracks

(East and West Lines combined: 1941 inspection)

(10)

Species	Ties placed	Actual average service life
	No.	Years
Beech	484	27.4
Birch	134	23.0
Hard maple	116	24.3
Soft maple	202	20.8
White oak	40	24.6
Red oak	285	24.6

Table 4.--Results from 42 years of testing on Baltimore & Ohio track at Backus, Pa.* (7)

Species	Ties placed	Ties in test	Removed to date		Average life
	No.	No.	No.	Percent	Years
Red oak	72	7	65	90	31.5
Black oak	260	17	243	93	32.5
Pin oak	316	17	299	95	32.6
Maple	543	143	400	74	34.1
Beech	824	100	724	88	31.5
Birch	19	4	15	79	31.2
Cherry	9	1	8	89	29.9
Gum	12	1	11	92	31.7
Chestnut	170	0	170	100	21.2
Hickory	146	9	137	94	30.0
All species	2,371	299	2,072	87	31.5

*Ties were treated with straight creosote at 10 pounds per cubic foot, and were placed in use in November 1910. Report is based on 1952 removals.

Table 5.--Results from 23 years of testing on Baltimore & Ohio track at Hills-Loveland, Ohio (7)

Kind of wood	Absorption*	Ties placed	Removed to date		Average life
	Pounds	No.	No.	Percent	Years
Chestnut	8.97	400	398	99.5	12.8
Gum	8.97	400	11	2.7	21.9
Hickory	8.48	400	48	12.0	21.5
Sap beech	8.97	200	10	5.0	21.9
Heart beech	10.47	200	14	7.0	21.9
White oak	5.47	600	19	3.2	21.9
Red oak	8.15	743	105	14.1	21.6

*60 percent creosote, 40 percent petroleum.

Through every favorable mention of the service life of treated beech ties runs the refrain that these ties were either "white heartwood" or were "sap-bound" ties, cut from very small trees with a small amount of entirely enclosed heartwood. It is usually also pointed out that the ties received "unusually heavy" treatment of creosote (in one case up to 20 pounds per cubic foot). The evidence appears to be that selected beech, cut from young "sappy" trees or older trees with white heartwood, rapidly moved to the yard, promptly milled, incised, carefully dried, and heavily treated with creosote, will make an excellent tie.

It would seem that a program of purchasing beech ties, based on the foregoing specifications, would help the railroads, the sawmills, and the forest managers of the Northeast. Yet because of the special selection and handling required to make satisfactory beech ties, it is very unlikely that the industry will turn to beech--at least under current conditions--as an important source of tie material.

SUMMARY

Although more than one-fifth of the nation's Class I railroad trackage lies within an area where beech is an important forest species, very little beech is now being used for railroad ties. This is due largely to lack of experience with properly selected, seasoned, and treated beech ties, plus the ready availability of quantities of other species (mainly red oak) which are in use, are easier to season and

treat, and make ties of excellent quality. Yet in strength properties and resistance to wear, beech is comparable to most woods used; and when properly handled in logging and seasoning, selected beech can be pressure-treated with creosote so that in use it is as decay-resistant as other currently used treated woods.

In spite of this, the widespread prejudice against beech persists. The author believes that the railroads are ignoring beech to their own economic disadvantage; and he believes that they will continue to do so unless or until a greatly increased stumpage cost for red oak--or loss of red oak supplies through insects or disease--forces them to reconsider their tie-purchase policies.

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AGRICULTURE-FOREST SERVICE-UPPER DARBY

(CONTINUED FROM INSIDE OF FRONT COVER)

* Chemistry and chemical utilization of beech.
* Silvicultural characteristics of beech.
  Availability and supply of beech.
  Present markets and uses for beech.
* Logging beech and specifications for products.
* Seasoning beech lumber.
* Storage of beech logs and bolts.
* Machining of beech.
  Milling of beech.
* Gluing techniques for beech.
* Steam-bending of beech.
  Preservative treatment of beech.
* Beech for flooring.
  Beech for furniture.
  Beech for turned products and novelties.
* Beech for veneer and plywood.
* Beech for fuel and charcoal.
* Beech for crossties.
* Beech for containers.
  Pulping and defiberization of beech.
* Rough construction on the farm with beech.

The Northeastern Station acknowledges gratefully the effort being devoted to these problems by the many agencies and individuals who are cooperating in this project. Among the leaders in it are David B. Cook, New York State Conservation Department; Claude Bell, U.S. Forest Products Laboratory; A. H. Bishop, State University of New York, College of Forestry; and Fred Wangaard, Yale University School of Forestry. These men, along with Fred C. Simmons and C. R. Lockard of the Northeastern Station, comprise the working committee that is directing and coordinating the project.

The information gathered in this widespread cooperative project should be of great use to the wood-using industries of the regions where the wood of American beech is available.

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*Reports published.